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U.S. AIR FORCE

Titanium Procurement Lessons Learned

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04 August, 2008

Briefing Outline

- **F-22 Program Background**
- **Ti Study Lessons Learned**
- **Recommendations**
- **Summary**

F-22 Program Background

- From 2004 to 2006, the price of Ti raw material increased by almost 500%
- Lead times to procure raw material increased over 300%
- The buy to fly ratio of Ti parts in the F-22 program was high with a 92% scrap content
  - Buy 110,239 lbs to yield 10,043 fly-away, 11 to 1 ratio

- Demand for Aerospace grade Ti is expected to continue to grow significantly

Titanium Industrial Base

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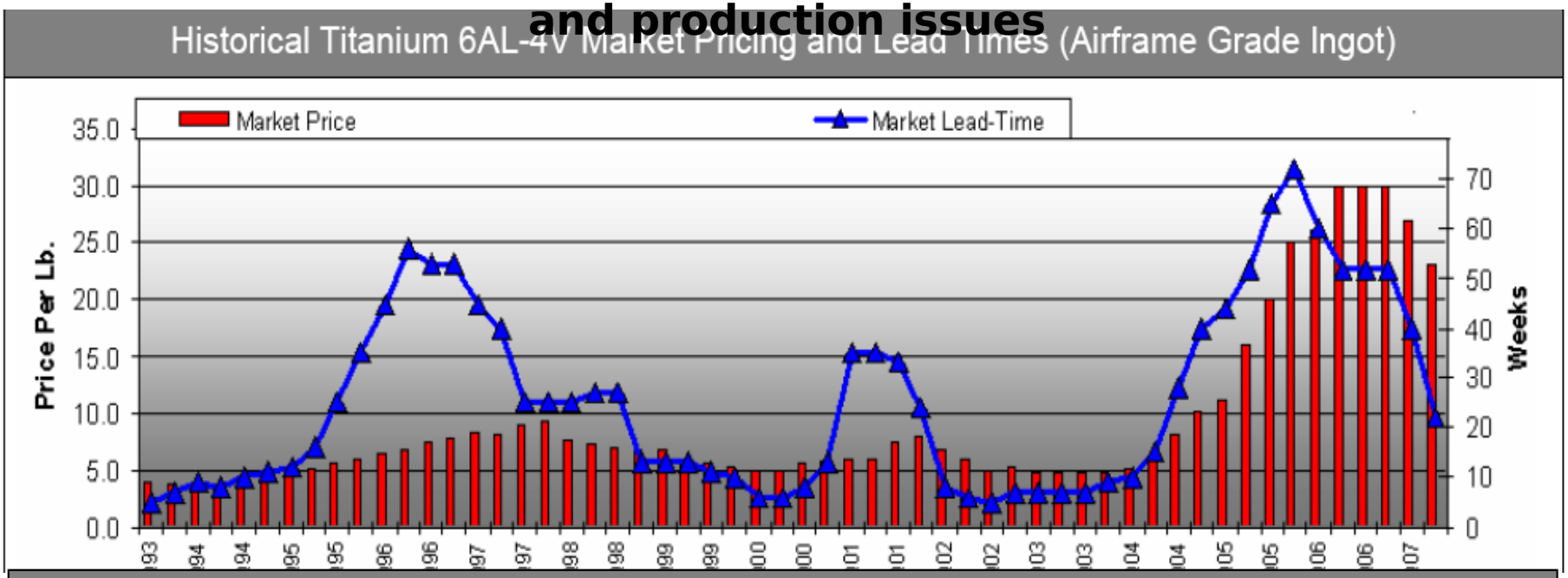
In 2005/2006, Titanium raw material prices as well as lead times reached an all-time high due to several macroeconomic factors and production issues



Identified Factors Influencing Price and Lead Time Spikes

- Increased Demand for Titanium from non-aerospace industrial sectors like oil & gas, commercial, etc.
- Diversion of Titanium scrap and sponge to the Ferro-Titanium industry (shortage of scrap for 70% Fe-Ti)
- Pickup in the aerospace industry
- Shortages in the supply of sponge and scrap
- Panic buying and stockpiling by end-users (e.g. milling shops and forging houses)
- Quality issues at the raw material producers

Titanium Market Projections

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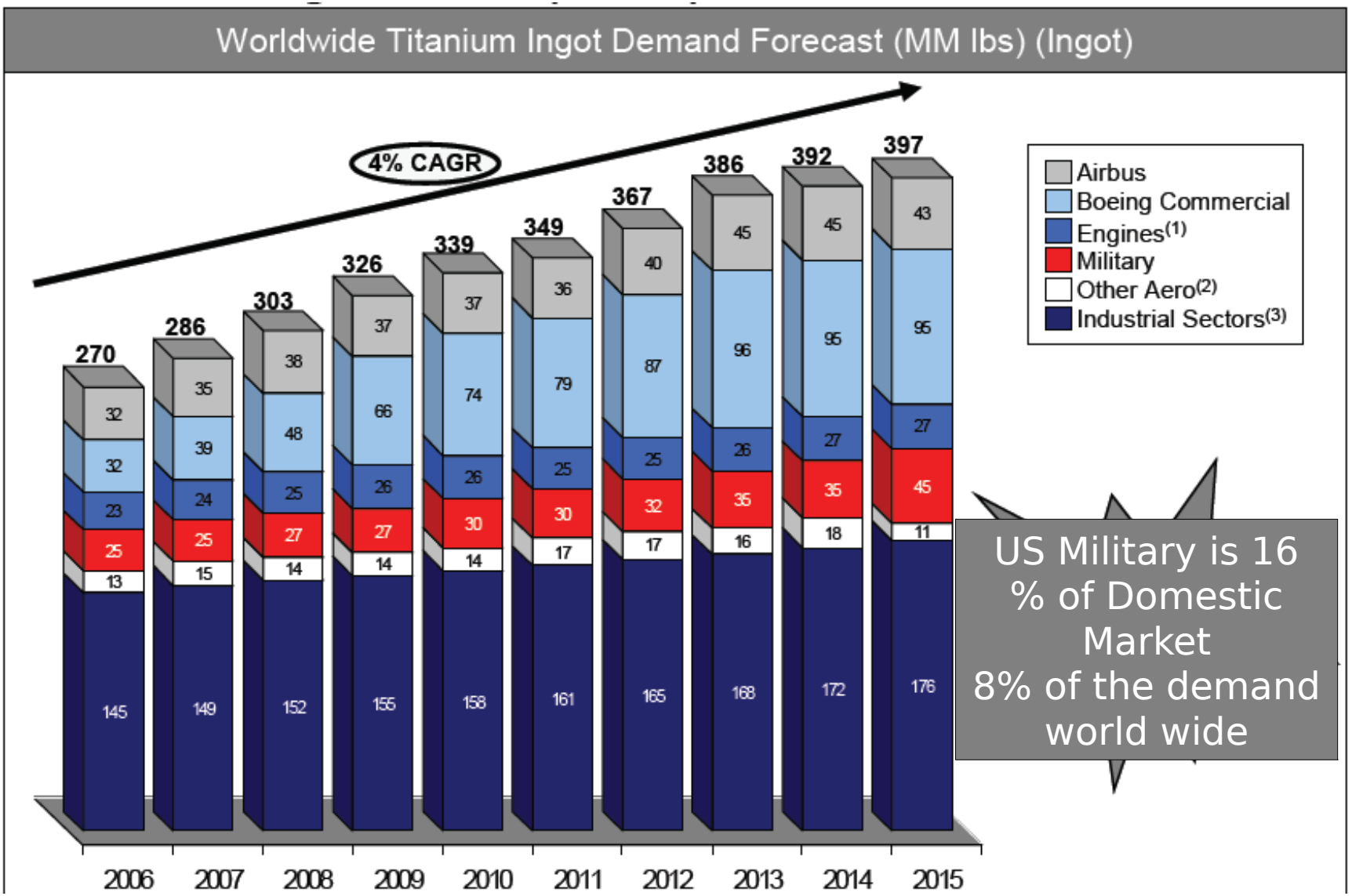

Titanium Study Overview

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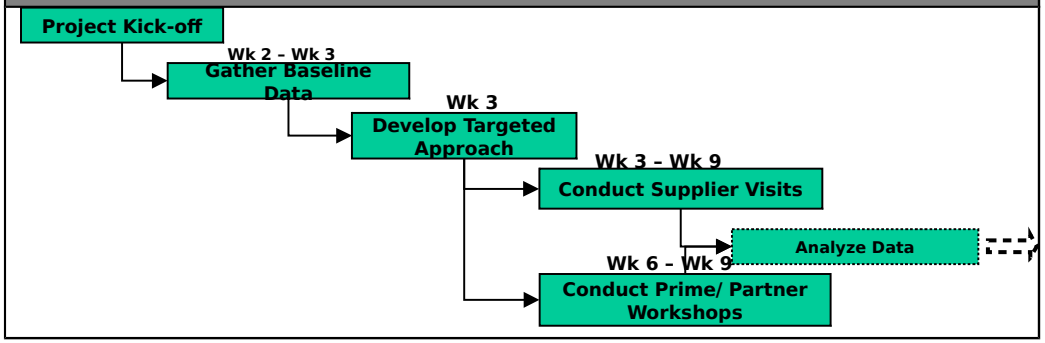
Project Objectives, Scope, and Chronology

To identify potential cost savings across the entire value stream for titanium structural airframe parts on F-22 and F-35

15 Week Effort

26 supplier visits, including raw material producers, forging and casting suppliers, machining suppliers, and scrap

Project Chronology



Key Points

- Total Titanium part numbers:
  - F-22: 2,517
  - F-35: 1,313 (all 3 variants)
- 26 suppliers visited
  - 4 raw material suppliers
  - 2 forging suppliers
  - 1 casting supplier
  - 17 machining suppliers
  - 2 scrap consolidators
- Target parts:
  - F-22: 200 parts (~85% of the buy weight)
  - F-35: 225 parts – 75 parts/variant (~90% of buy weight)

NOTE:

- Baseline data does not include Ti parts from the engine, landing gear, fasteners & tubing for both the F-22 and F-35

Ti Value Stream Map

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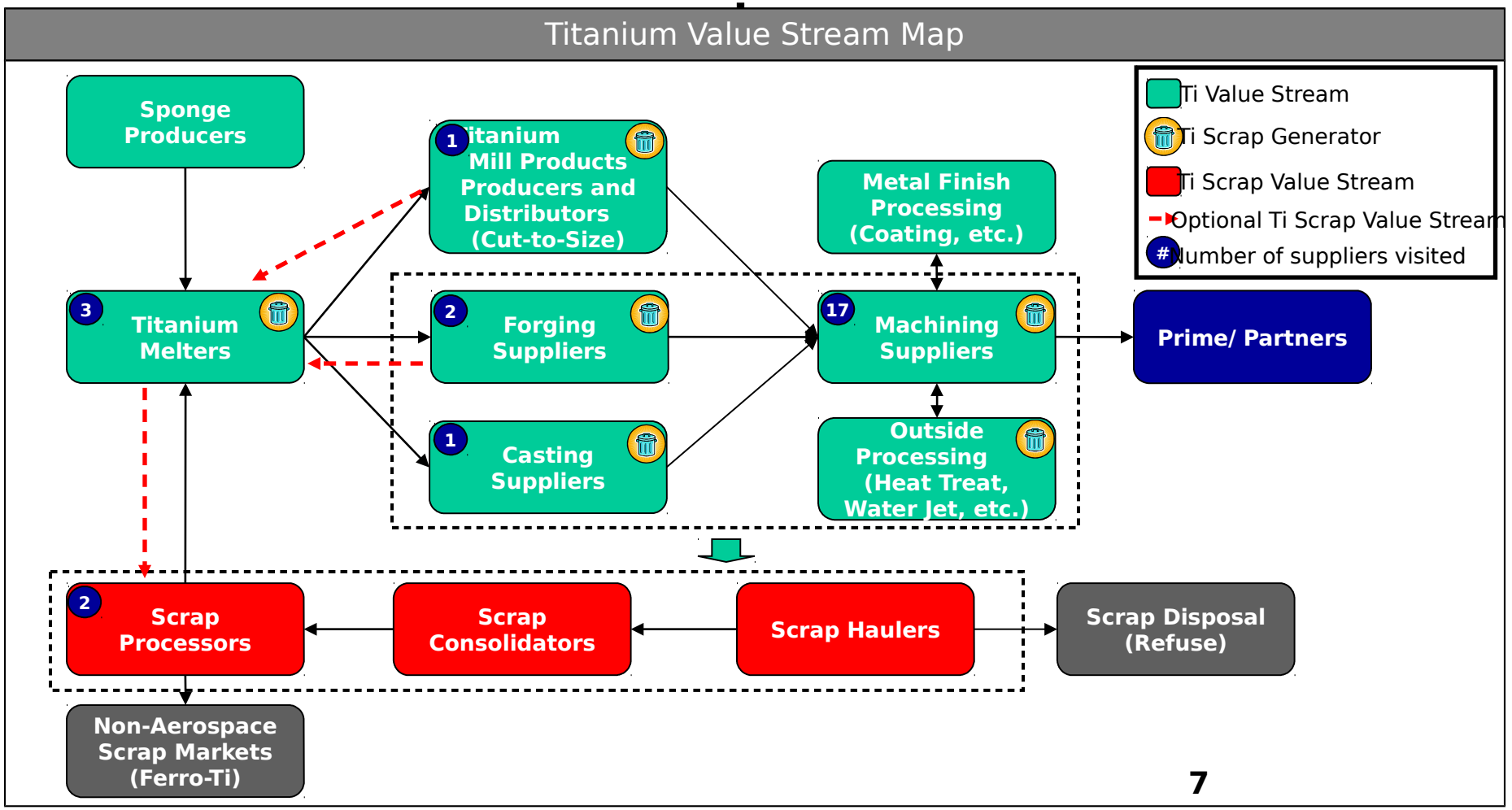
F-22

The team actively studied the Titanium processing and scrap value streams to identify potential opportunities for cost



Titanium Study Findings

Opportunities to Reduce Cost through Improved Management

- **Efficiency of Material Utilization**
  - **Buy Weight - use smaller ingot/plate**
    - **Adjustment to spec'd material sizes during study found LMA could cut "buy weight" from 107,962 lbs to 100,836 lbs or 7%**
  - **Part Nesting – Manage Offal**
    - **Large parts generate offal big enough to contain smaller parts**
  - **Scrap Recovery**
    - **Not all machine shops capture all the scrap – e.g. chip contamination**
    - **Need visibility into scrap recovery at time of competitive bid**
- **Efficiency in Contracting**
  - **Contract Add-On Costs**
    - **SG&A (Sales, General and Administrative)** [8]

Typical Production Build Schedule

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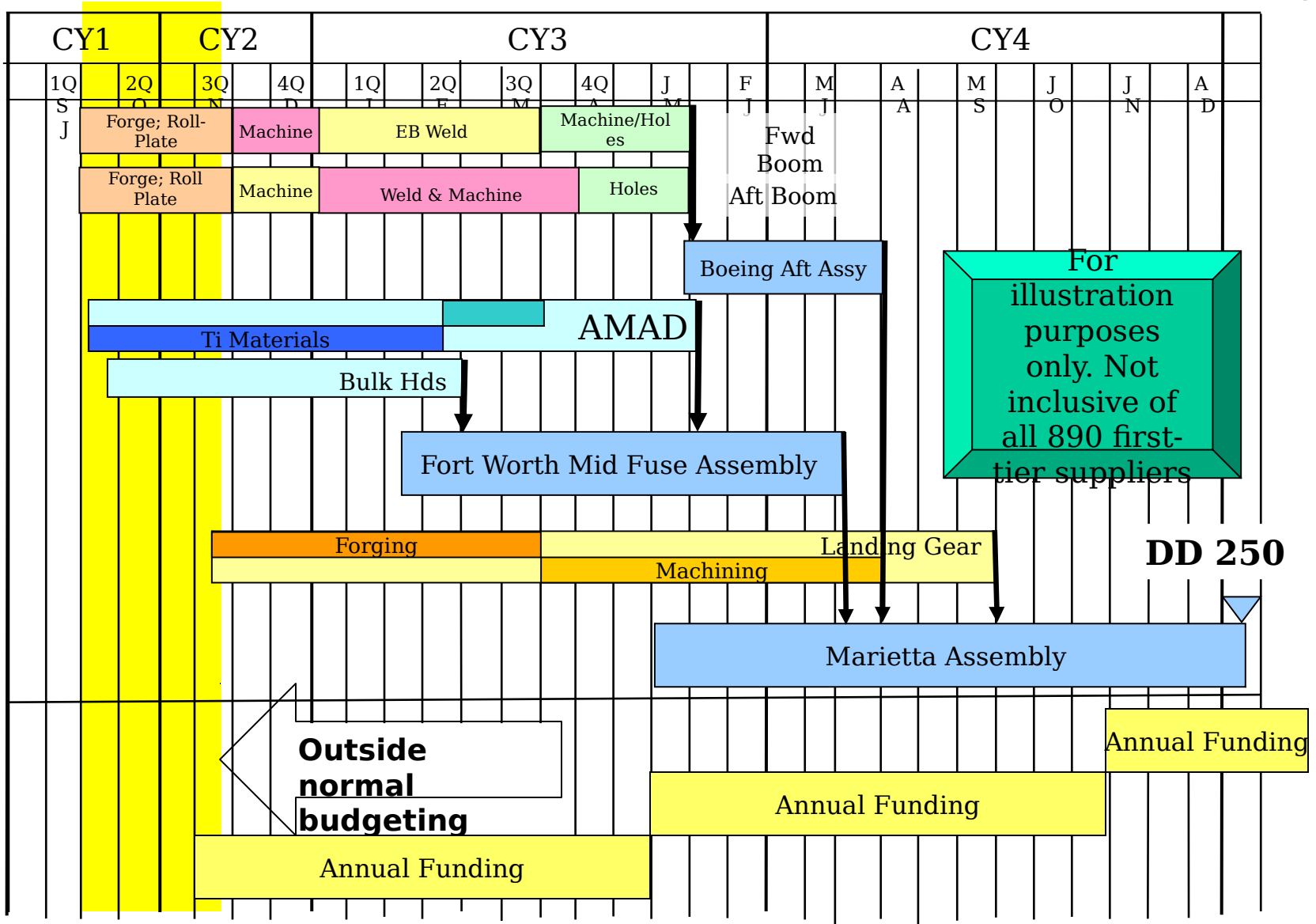
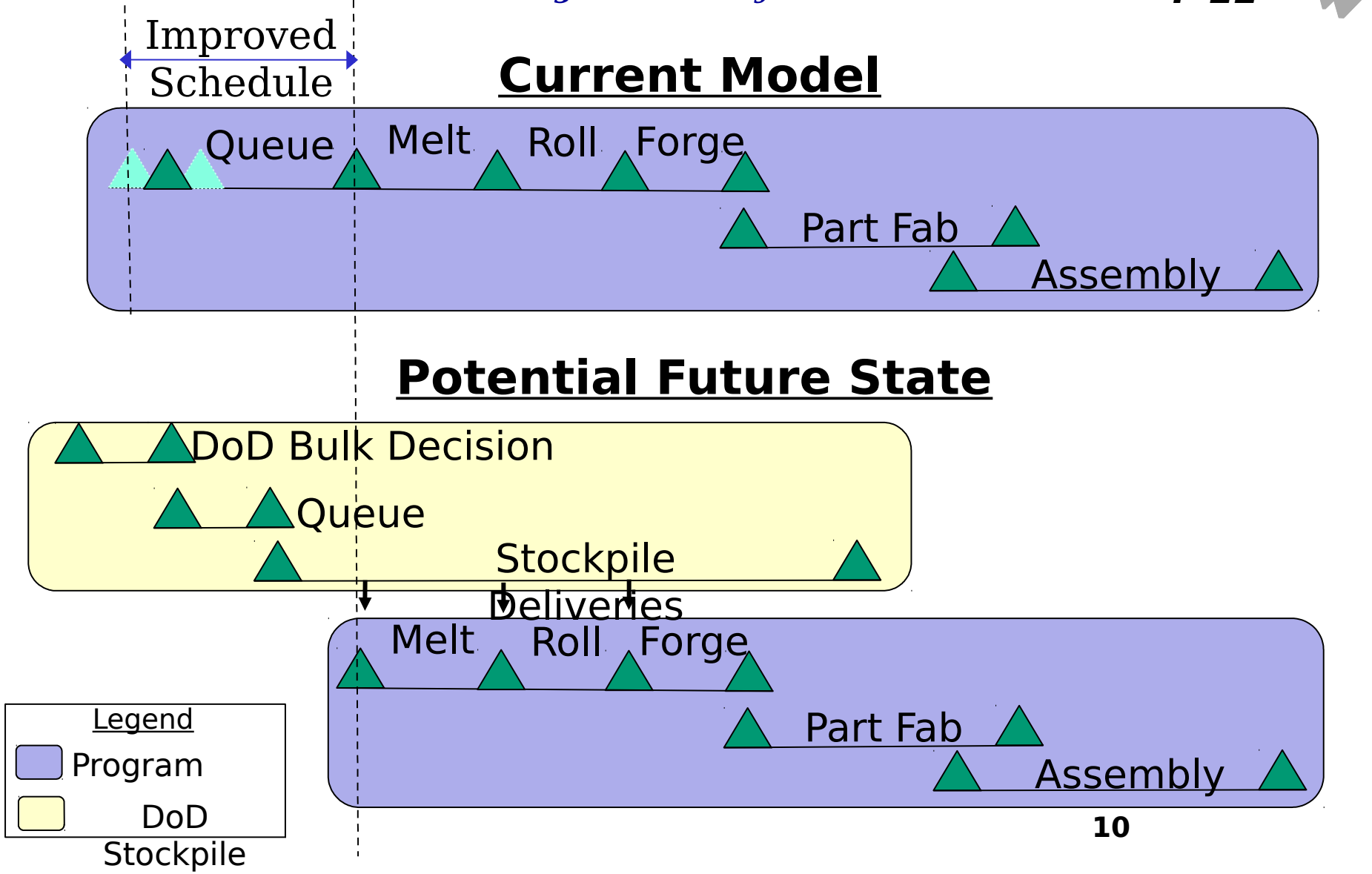


Options for a Better Business Model



Options for a Better Business Model

- **Buy and stockpile material**
- **National Stockpile Center**
- **Buffer queue to help reduce lead times**
  - **F-22 Ti lead times**
  - **Part lead times**
  - **Purchase Order lead times**
  - **Budget Vs Lead times**
- **What to buy?**
  - **Alloy mix**
  - **Reduce part numbers**
  - **Forecasts? (under source vs over source)**
  - **Buy a capability**
- **Ti process stage**
  - **Sponge, ingot, plate**
- **Single process initiative**

Market Fluctuations

Constant Supply

Options for a Better Business Model

- **Government qualification of suppliers**
  - **Enterprise vs program part specific**
  - **Application: Aerospace – Shipbuilding – Armored Vehicle**
- **There are many stakeholders**
  - **Require process changes with each stakeholder**
- **Pooling purchase of Ti increases buying leverage**
- **Long term purchasing agreements level spikes in price**

Ti Study Conclusions

- **Study recommendations highlight areas where greater management attention can provide significant improvement**
- **An open minded view of the value stream may lead us to additional innovative improvement**
- **No opportunities should be wasted & business as usual should NOT be the standard**